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Phoenix Innovation, Inc.

Mr. Tony Chou, Patent Examiner
Art Group 1745
US Patent and Trademark Office
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

January 30, 2007

Dear Mr. Chou:

RE: Application No. 10/668,976

Please find enclosed our response to your office action of 11/03/200. Please be advised that, being a small entity, we can no longer afford the cost of representation by our former law counsel Burns and Levinson, so we have elected to prosecute this application ourselves. In that regard, we have included a narrative response to your objections, an updated Figure 1 and a revised copy of the specification and claims. The changes in the specification and claims are in red font to clarify these changes. Figure 1 has been altered to include a load resistor to ensure that the figure properly reflects a battery, an oversight I the first iteration. Also, it was clear form your objections that it was not made clear in the specification that we have invented a battery that requires prelithiation of the anode before assembly. Under these circumstances, although both electrodes are composed of carbon nanotubes, they are not identical. Example 1 in the specification, as well as new information in the specification clarify this point. In addition, we have included new claims to provide further clarification of this point.

We look forward to future correspondence regarding this application.

Sincerely,

R. Scott Morris
Vice President

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Response to Office action of 11/03/2006

In our invention, both electrodes are composed entirely of CNTs, the CNTs are the active material. We apologize if the examiner interpreted our disclosure otherwise. The CNTs are the active material in our invention.

The following is a point by point response to the examiner's objections to our invention disclosure.

11. Ochoa et al ((US2003/0099883) teach that the combination of CNTs with the traditional materials that comprise electrodes in a Li-ion battery configuration will enhance the performance of those electrodes and of the battery overall. This is not surprising and is a direct result of the improved electronic conductivity of the composite electrodes that results from inclusion of the CNTs. However, Ochoa teaches that the CNTs are fillers in these electrodes and that the activity of the electrodes is accomplished by the traditional materials employe din these electrodes. In fact, Ochoa teaches that 0.5 – 1 wt% (see examples) is the optimum quantity of CNT additive needed to effect this improvement. In addition, in paragraph 0014, Ochoa states "...it is ill-advised to eliminate carbon black altogether." It is obvious from this statement that the CNTs in Ochoa's invention are auxiliary additives and not the main players in the electrodes. This is precisely the point of our invention, we have eliminated carbon black altogether as well as graphite in the anode. In our invention, both electrodes are composed entirely of CNTs. The anode is prelithiated, but we are not using CNTs as a conductive filler as Ochoa teaches, the CNTs are the active material. We apologize if the examiner interpreted our disclosure otherwise. The CNTs are the active material in our invention.

13. Although Ochoa teaches that CNTs can be included as additives in a Li-ion battery, he does not anticipate the use of these fillers as active materials in the battery and as previously stated, admits this in his specification and in his claims. In claim 7, Ochoa states "a battery as in claim 1, wherein the single walled carbon nanotube additive is present in at most one percent of the electrode by weight". In US6422450 Zhou et al primarily teach the method for preparing SWNT and their purification. In column one lines 44 – 46, the Zhou et al describe the fabrication and testing of a battery in which the CNT electrode forms one electrode and a lithium foil forms the second electrode. Nowhere in US6422450 is a cell comprised of one lithiated CNT electrode and one pure CNT electrode described. One can conclude from these two patents that Ochoa teaches away from using CNTs as the active material in both electrodes in a Li-ion cell and Zhou teaches the use of CNTs for use in only one electrode in a Li-ion cell. Therefore, the combination of the two patents does not constitute a description of the instant invention and therefore, is not obvious to one skilled in the art.

14. Once again, Ochoa does not teach the use of CNTs as the active material in a lithium-ion battery and even though Chaloner-Gill (US5521025) teaches the use of a polyether phosphate solid polymer electrolyte in a battery in which one electrode contains lithium, one skilled in the art could not anticipate that the combination of the teaching s of Ochoa et al and Chaloner-Gill

could lead to a lithium-ion battery in which the two electrodes are composed of active CNTs and a polyether phosphate electrolyte.

15. To begin with, to respond to the editor's note for this claim rejection; lithiated CNTs of the empirical formula LiC_3 and lithium metal oxides with the empirical formula $LiNi_{(1-x)}Co_xO_2$ are chemically distinct. Both contain lithium, but in far different ways, chemically. The lithium in the metal oxide positive electrode (cathode) is in the form of a spinel which is chemically distinct in every way from a lithitiated CNT electrode. The common method for preparing a Li-ion battery is to begin with a lithium metal oxide spinel cathode and an unlithiated carbon anode. At this point, the editor is correct that the cell is in the discharged state and the lithium reides in the positive electrode. Once again, this is distinct from the instant invention where the lithium resides in the negative electrode (prelithiated CNT electrode) and upon discharge, the lithium is transported to the positive electrode. This is not intuitive or obvious to one skilled in the art. To go further, Chen et al (US7060390) are very restrictive in their description of the MWNT used in the negative (anode) electrode. They go so far as to describe the anode in their claims as being a plurality of MWNTs formed on a substrate in parallel. The instant invention does not in any way restrict the types of MWNT or SWNT used in either electrode. Finally, since the examiner uses Ochoa as the basis for his objection to out claims in view of 35 USC 103(a), we must again point out that Ochoa does teaches away from using CNTs as active materials in Li-ion battery electrodes.

16. Not to be too repetitive, but once again, Ochoa teaches that the CNTs in their electrodes serve as a conductive additive and likewise, Ogura et al (US2002/0061441) teach the same doctrine as evidenced in paragraph 0037 where they state that the CNTs "...decrease the electrical resistance of the matrix" and "..the presence of the CNTS as a filler increases the mechanical strength of the matrix". Nowhere in their disclosure do Ogura et al mention the use of the CNTs as the active material in their electrode. In fact, the Ogura et al electrode is a sulfur-based material and the electrochemical oxidation and reduction of the disulfide bond is the basis for this positive (cathode) electrode's function in the battery. The examiner's reference to the use of ozone to treat the CNTs in the Ogura et al electrode deals with improving the quality of the CNTs through chemical treatment. In our invention, the purpose of chemically treating he CNTs is to increase their ability to intercalate lithium. This is not apparent in Ogura et al disclosure and could not be concluded by one skilled in the art through comparison of Ogura et al and Ochoa at al.

17. Yet again, Ochoa et al teach the use of CNTs as a conductive additive in conventional Li-ion electrodes. While we concede that Peng et al *(Nanoletters* 1 , 11, 625-29, 2001) originated the concept of improving the lithium intercalation capability of CNTs by fluorinating them, it should be noted that Peng et al tested their fluorinated tubes in a "lithium electrochemical cell" (p626 paragraph 2). This means that lithium metal constituted the counter electrode in their test cell. Since Ochoa teaches that CNTs are a filler in his electrodes and Peng utilized a metallic lithium counter electrode in his test cell, it is not intuitive to one skilled in the art to combine a fluorinated CNT positive electrode (cathode with a prelithiated CNT negative electrode to form a useful electrochemical cell.

18. Again, Ochoa does not anticipate using CNTs as the active material in Li-ion electrodes so that incorporation of conducting polymers with CNTs in one or the other electrodes in the battery configuration described in the instant invention would not be obvious to one skilled in the art. While Chen et al (US2003/0077515) claim the combination of conducting polymers with CNTs as electrodes in a secondary battery. However, like many in the field, Chen utilizes CNTs in his electrode as the substrate for growing the polymerized conducting polymer. The conducting polmer serves as the electrochemically active material in the Chen invention and the CNTs are the conductive support. For instance in paragraph 0086 he states" ...in this example is to grow a conducting polymer film on an electrode surface using ionized (anionic) carbon nanotubes as the dopant". In the instant invention we seek to do the opposite, i.e. use the conducting polymers as as an additive to the CNTs.

19. Again, Ochoa does not anticipate using CNTs as the active material in Li-ion electrodes so that incorporation of a phosphate ester in the instant invention would not be anticipated by Ochoa. We also argue that Geronov (US6344293), much as Ogura et al, describes a battery that contains an electroactive sulfur compound cathode (positive electrode) and a metallic lithium negative (anode) electrode. Considering these facts, it is not at all obvious to one skilled in the art that the combination of these two patents could anticipate the instant invention.

20. In claims 22 and 23 we claim a LiSiC in our CNT/CNT battery in which the LiSiC composite is a CNT material. Ochoa does not anticipate using CNTs as active materials in his battery and although Yang et al (Electrochem Solid State Lttrs) describes a LiSiC composite, in this instance, said composite is comprised of pyrolyzed carbon combined with Si and graphite nanoparticles as an intercalation medium for lithium. Nowhere in his abstract does Yang mention CNTs. Therefore, combination of Yang's abstract with Ochoa's patent disclosure does not rersult in an invention that would be obvious to one skilled in the art.